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CLAIMS

1. Single stage laser amplifying apparatus comprising:

an oscillator assembly for providing input light to be amplified;

a pump laser for providing pumping; and

an amplifier for amplifying the input light from on the order of 10^{-9} Joules to on the order of 10^{-3} Joules, the amplifier pumped by the pump laser;

wherein the amplifier includes a cryogenically-cooled amplifying medium; and

wherein the amplifier provides substantially all of the amplification of the amplifying apparatus.

2. The apparatus of claim 1, wherein the average power provided by the apparatus is between 1 Watt and 100 Watts.

3. The apparatus of claim 1, wherein the beam quality $M^2 < 2$.

4. The apparatus of claim 1, wherein the amplifying medium is a non-linear parametric amplification medium.

5. The apparatus of claim 4, in a single pass, high gain configuration.

6. The apparatus of claim 1, in a regenerative amplifier configuration.

7. The apparatus of claim 1, in a multipass amplifier configuration.

8. The apparatus of claim 1, wherein the amplifying medium has a host

selected from the following list -

a) Sapphire (Al_2O_3),

b) Yttrium-Aluminum Garnett ($Y_2Al_5O_{12}$),

c) Yttrium-Lithium Flouride ($LiYF_4$),

d) LiSAF ($LiSrAlF_4$),

e) LiCAF ($LiCaAlF_4$),

f) $KY(WO_4)_2$)

g) YVO_4, or

h) $YAlO_3$;

and wherein the the amplifying dopant has a host selected from the following list -

a) Titanium (Ti^{3+}),

b) Neodymium (Nd^{3+}),

c) Chromium (Cr^{3+}),

d) Holmium (Ho^{3+}),

e) Erbium (Er^{3+}),

f) Thulium (Tm^{3+}),

g) Praseodymium (Pr^{3+}),

h) Ytterbium (Yb^{3+}),

i) Europium (Eu^{3+}),

j) Dysprosium (Dy^{3+}), or

k) Terbium (Tb^{3+}).

9. The apparatus of claim 1, wherein the amplifying medium comprises titanium doped sapphire.

10. The apparatus of claim 1, further including fiber optics for transmitting light between the pump laser and the amplifier.

11. The apparatus of claim 1, wherein the pump laser is selected from the following list:

    a) diode-pumped frequency doubled Nd:YAG,
    b) lamp-pumped frequency doubled Nd:YAG
    c) semiconductor diode laser,
    d) ruby laser,
    e) diode-pumped Nd:Vanadate, or
    f) diode-pumped Nd:YLf.

12. Single stage laser amplifying apparatus comprising:

an oscillator assembly for providing input pulses to be amplified;

a pump laser for providing pumping; and

an amplifier for amplifying the input pulses [high gain], the amplifier pumped by the pump laser;

wherein the amplifier includes a cryogenically cooled amplifying medium;

wherein the amplifier provides substantially all of the amplification of the amplifying apparatus; and

wherein the amplifying medium is selected from the following list:

a) $Nd^{3+}:Y_3Al_5O_{12}$

b) $Nd^{3+}:YAlO_3$

c) $Ti^{3+}:Al_2O_3$

d) $Ce^{3+}:LiCaAlF_4$

e) $Ce^{3+}:LiSrAlF_4$

f) $Nd^{3+}:LiYF_4$

g) $Yb^{3+}:Y_3Al_5O_{12}$

h) $Cr^{3+}:Al_2O_3$

i) $Cr^{3+}:LiCaAlF_4$

j) $Cr^{3+}:LiSrAlF_4$

k) $Pr^{3+}:LiYF_4$

l) $Nd^{3+}:KY(WO_4)_2$

m) $Ho^{3+}:YAlO_3$

n) $Ho^{3+}:Y_3Al_5O_{12}$

o) $Ho^{3+}:LiYF_4$

p) $Er^{3+}:LiYF_4$

q) $Er^{3+}:Y_3Al_5O_{12}$

r) $Er^{3+}:YAlO_3$

s) $Tm^{3+}:YAlO_3$

t) $Tm^{3+}:Y_3Al_5O_{12}$

13. The method of amplifying a coherent light beam in a single stage, comprising the steps of:

providing coherent input light to be amplified;

pumping the coherent light with a pump laser; and

amplifying the pumped coherent light from on the order of 10^{-9} Joules to on the order of 10^{-3} Joules with an amplifier;

wherein the amplifier includes a cryogenically-cooled amplifying medium; and

wherein the amplifier provides substantially all of the amplification of the amplifying apparatus.

14. The apparatus of claim 13, wherein the average power provided by the apparatus is between 1 Watt and 100 Watts.

15. The apparatus of claim 13, wherein the beam quality $M^2 < 2$.

16. The apparatus of claim 13, wherein the amplifying medium is a non-linear parametric amplification medium.

17. The apparatus of claim 16, in a single pass, high gain configuration.

18. The apparatus of claim 13, in a regenerative amplifier configuration.

19. The apparatus of claim 13, in a multipass amplifier configuration.

20. The apparatus of claim 13, wherein the amplifying medium has a host selected from the following list -

a) Sapphire (Al_2O_3),

b) Yttrium-Aluminum Garnett ($Y_2Al_5O_{12}$),

c) Yttrium-Aluminum Flouride ($LiYF_4$),

d) LiSAF ($LiSrAlF_4$),

e) LiCAF ($LiCaAlF_4$),

f) YVO_4, or

g) $YAlO_3$;

and wherein the the amplifying dopant has a host selected from the following list -

a) titanium (Ti^{3+}),

b) neodymium (Nd^{3+}),

c) chromium (Cr^{3+}),

d) holmium (Ho^{3+}),

e) erbium (Er^{3+}),

f) thulium (Tm^{3+}),

g) praseodymium (Pr^{3+}),

h) ytterbium (Yb^{3+}),

i) europium (Eu^{3+}),

j) dysprosium (Dy^{3+}), or

k) terbium (Tb^{3+}).